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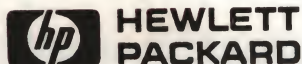
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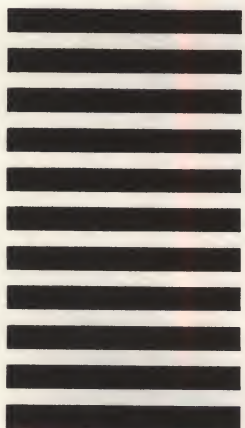
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Introduction

This booklet describes key networking concepts and provides an overview of HP-UX networking products. The information applies to all HP 9000 computer systems. Any exceptions are specifically noted.

HP-UX networking products described in this booklet include the following:

- LAN/9000 Link.
- X.25/9000 Link.
- OSI (Open Systems Interconnection) Express MAP 3.0 Link
- OTS/9000 (OSI Transport Services)
- ARPA Services/9000.
- NFS Services/9000 (Network File System).
- NS/9000 (Network Services).
- FTAM (File Transfer, Access, and Management).
- MMS (Manufacturing Message Specification).
- X.400/9000 Messaging Service.

Note

The information in this booklet is current at the time of publication but may change after that. For the latest product and ordering information, call your local HP representative.

Networking Concepts

This chapter provides an overview of general networking concepts as they relate to HP 9000 networking products.

For an introduction to general networking concepts, read these sections:

- “Networks and Nodes”
- “Network Addresses”
- “Bus Networks”
- “X.25 Packet Switching Networks”
- “Protocols”

For an overview of how the network handles different communications tasks, read these sections:

- “Network Architecture and the OSI Model”
- “HP-UX Networking”
 - “Services”
 - “Transports”
 - “Links”

Networks and Nodes

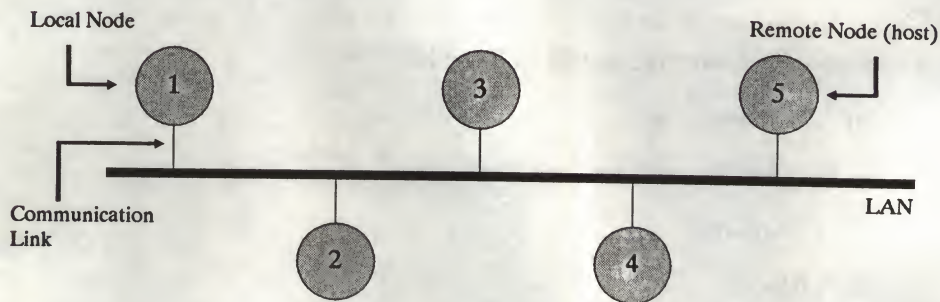
A **network** is a group of computer systems connected so that they can exchange information and share resources such as disc space, printers and plotters.

A **node** or **host** is a computer on a network. The term **local node** refers to the node or host to which your terminal is physically attached. A **remote node** is a computer on the network with which your local node can communicate.

Nodes or hosts on a network are connected by **communication links**. A communication link is the hardware (e.g., cables) and executable software that enable network nodes to exchange data. All network nodes that need to exchange data must be connected by the same type of link.

When computers in a network are geographically remote from each other (across cities, states or countries), the network is called a **Wide-Area Network (WAN)**. When the geographic coverage of a network is much smaller (within a building or spread among closely spaced buildings), it is called a **Local-Area Network (LAN)**.

The illustration shows a local area network (LAN) with five nodes, each represented by a circle. Communication links, represented by lines, join the nodes to the LAN.



Example of a Bus Network

In this example, if you are a user logged into node 1 (or host 1), node 1 is your **local node**. Nodes 2, 3, 4 and 5 are **remote nodes**.

If you send a message from node 1 to node 5, node 1 is the **source node** and node 5 is the **destination node**. Nodes 2, 3, and 4 "see" the message after it is sent from node 1, but pay no attention to it because it is addressed to node 5. So your message follows a route that includes nodes 1 and 5. A **route** is the sequence of network nodes that a message travels through when it is sent from a source node to a destination node.

Network Addresses

To send a message, a node must be able to provide a network address for the recipient of the message. That is, every message has to have the identity of the recipient (or a connection identifier) attached.

Different types of networks use different addressing schemes. One type of address identifies a particular hardware card on a particular host; another type of address identifies a software process rather than hardware. The key idea is that a network address specifies the destination for a message.

Bus Networks

The figure on the previous page is an example of a **bus network**. Nodes in a bus network are connected by a linear run of cable. Every node simultaneously reads each message transmitted over the network. The nodes typically process messages addressed to themselves and ignore all other messages. HP 9000 LANs are one of two LAN types, CSMA/CD or token bus, depending on how the nodes access the network.

CSMA/CD Networks

Ethernet¹ and IEEE 802.3² LANs are bus networks. Their network access method is known as Carrier-Sense, Multiple-Access with Collision Detection (CSMA/CD). This means that a node "listens" to see if the network is busy before it transmits. All nodes have equal access to the network and can detect and recover when two nodes attempt to transmit at once.

Ethernet and IEEE 802.3 LANs package the information that moves across the cable differently. An HP 9000 computer can determine which type of data package format a remote node is using. If the remote node can communicate on both types of LANs, the HP 9000 computer can communicate with it using the same data package format that the remote node is using. This makes it possible to use the ARPA product, the NFS Services product, and the NS product on IEEE 802.3 and Ethernet LANs simultaneously.

Token Bus Networks

IEEE 802.4 networks use a "token bus" access method. In a token bus network, a special bit pattern called a "token" circulates among the nodes on the network. A node is permitted to transmit only when it holds the token. Therefore, collisions between nodes seeking simultaneous access to the network cannot occur, and all nodes can be guaranteed access to the network within a known time period. MAP 3.0 networks use the IEEE 802.4 specification; this is partly because of the access guarantee, and partly because IEEE 802.4 is especially suited to harsh manufacturing environments.

-
- (1) The Ethernet LAN is a local area network system developed by Digital Equipment Corp., Intel Corporation and Xerox Corporation. Ethernet is the de facto standard for office automation and distributed processing LANs.
 - (2) The IEEE 802.3 LAN is a networking standard similar to Ethernet that is accepted by the Institute of Electrical and Electronic Engineers.

X.25 Packet Switching Networks

Wide-area networks (WANs) use a technology known as packet switching. With packet switching, messages are broken down into data packets and sent across the network. When the packets reach their destination, they are reassembled into the original messages.

A WAN that uses packet switching is called a **Packet Switching Network (PSN)**. X.25³ is a recommendation that defines the protocol required to access a PSN.

Protocols

A **protocol** is a set of rules for a particular communication task. It handles the format of information packets, the amount of data they contain, and procedures for exchanging the packets at the interface between the network and the computer. A protocol handler or module is a piece of software that implements a particular protocol.

HP has implemented protocols with wide industry acceptance:

- The TCP/IP protocol supports ARPA, NS, and NFS running over Ethernet links.
- HP's Open Systems Interconnection (OSI) products are based on standards developed by the International Organization for Standardization (ISO). These products provide basic services designed for multivendor interoperability.

HP networking products provide easy migration from the older TCP/IP protocols to the multivendor environment of OSI.

(3) Its full name is "CCITT (International Telegraph and Telephone Consultative Committee) Recommendation X.25," and it is defined in "CCITT Red Book Volume VII Data Communications Networks Interfaces Recommendations X.20–X.32, 1984".

Gateways, Routers, and Bridges

Gateways, routers, and bridges are devices that enable different networks to communicate with each other. Each device has different capabilities.

Networks with different types of hardware and different protocols, such as TCP/IP and OSI, can communicate with each other via a **gateway**. Unlike a router or a bridge, a gateway can translate the protocol of one network to a different protocol used by another network.

Networks with different types of hardware but the same kind of networking software can communicate with each other via a **router**. A router can store and interpret information about networks and network routes, and forward packets to nodes that are not on directly attached networks.

Networks with the same type of LAN hardware and networking software can communicate with each other via a **bridge**. A bridge cannot forward packets to nodes that are not on directly attached networks.

Network Architecture and the OSI Model

A network architecture is a structured, modular design for networks. The Reference Model for Open Systems Interconnection (OSI) is a network architecture model developed by ISO. HP has based the development of its networking products on ISO's OSI model.

The LAN/9000 network (TCP/IP) and services are not strictly based on ISO OSI standards; however, the OSI model is still useful when discussing various functions in the TCP/IP protocol. On the other hand, the OSI-based networks (OTS/9000 and OSI Express) are implementations of ISO standards.

In the OSI model, communication tasks are assigned to seven logically distinct modules called **layers**. Each layer performs a specific data communication function. Interfaces between each layer allow each layer to communicate with the layers directly above it and below it. Each layer may also communicate with its peer layer on a remote computer. The function of each layer in the OSI model is described in the following table.

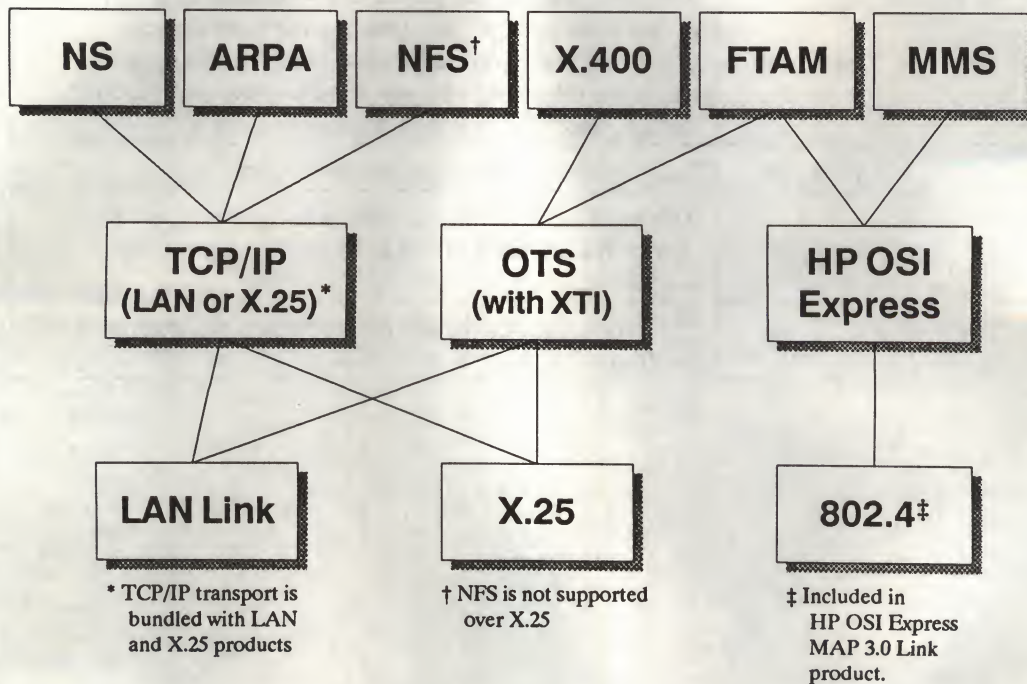
OSI Model

Layer	Layer Name	Layer Function
7	Application	This layer provides network services, including file transfer, terminal access, and other network applications.
6	Presentation	This layer resolves data formats between unlike computers.
5	Session	This layer is the user's link into the network. Connections are established and managed within the Session Layer.
4	Transport	This layer is responsible for end-to-end data integrity. It ensures that data arrives at the remote node without errors. Depending on the class of transports supported in this layer, the transport layer provides flow control, error control, and suppression of duplicated data.
3	Network	This layer routes messages between nodes.
2	Data Link	This layer creates message frames for transmission. It detects transmission errors and controls access to the medium.
1	Physical	The Physical Layer defines the electronic characteristics of the transmission medium.

HP-UX Networking

The functions of networking software are often divided into three categories: **services**, **transports**, and **links**. Each category generally corresponds with certain levels of the OSI model described on the previous page: **services** correspond with level 7, **transports** with levels 3 through 6, and **links** with levels 1 and 2.

As shown in the figure below, HP offers products in each of the three categories. The top row of boxes lists HP-UX service products; the middle row, transport products; and the bottom row, link products. The connecting lines show which services are supported over which transports and links.



Services, Transports, and Links for HP-UX Networking

The sections that follow describe in greater detail the TCP/IP and OSI networking products offered by HP.

Services

When you transfer a file, log in to a remote node, or attach a remote file system to your local node, you are using a network service. Services exist at layer 7 of the OSI model, known as the Application layer. OSI literature often uses the term "Application Services" to distinguish services at this layer from lower layer services.

There are six HP-UX service products:

- ARPA Services.
- NFS Services.
- NS Services.
- X.400.
- MMS.
- FTAM.

All services are described in the "HP 9000 TCP/IP Networking Overview" and "HP 9000 OSI Networking Overview" sections of this booklet.

Transports

Transports define how networks route data and ensure its integrity. "Transport functions" generally correspond to layers 3 through 6 of the OSI model. There is often programmatic access to one or more of these layers, for use by advanced application developers who need the connectivity and routing provided at these levels. OSI literature often refers to "Transport Services" or "Network Services" at these layers.

There are three HP-UX transport products:

- The LAN/9000 Link. The transport for TCP/IP networks, which include LANs running ARPA and NFS Services, is part of the LAN/9000 Link product.
- OTS/9000 (with XTI). OTS is HP's primary OSI transport product, supporting X.400 and FTAM.
- HP OSI Express. This is a MAP 3.0 transport, designed for factory automation networks.

Links

Links define how networks physically transmit data from one point to another. They include hardware and software for the lower OSI layers. The hardware includes the physical means of transmission such as interface controllers and cable. The software, corresponding to layers 1 and 2 of the OSI model, defines the way a network takes raw data and packs it into messages that can be transmitted.

There are three HP-UX link products:

- **LAN/9000 Link.** LAN links are used in local bus networks such as Ethernet and 802.3 networks.
- **X.25/9000 Link.** X.25 links are used for wide-area networks (WANs).
- **HP OSI Express MAP 3.0 Link.** This link is used for LANs in manufacturing environments.

The link products are discussed more in the "HP 9000 TCP/IP Networking Overview" and "HP 9000 OSI Networking Overview" sections of this booklet.

HP 9000 TCP/IP Networking Overview

This chapter provides an overview of HP's TCP/IP networking products. It also defines terms that apply to TCP/IP networking.

Overview

HP's TCP/IP networking products allow HP 9000 computers to communicate with other computers in LAN and WAN environments. They include the following products:

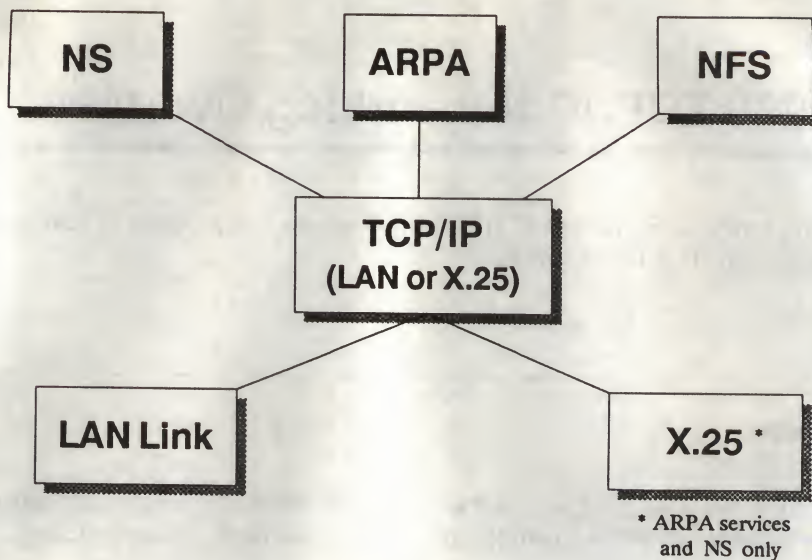
- ARPA Services, a defacto industry standard that provides connectivity and communications in a multivendor network of machines and operating systems.
- NFS Services, a collection of networking services that allow HP 9000 computers to share file systems among computers in a multivendor network.
- NS Services, an HP proprietary collection of networking services that enable HP 9000 computers to communicate with other HP computers as well as some IBM and DEC computers.

The above products run over the following link products:

- LAN/9000, a local-area network link.
- X.25/9000, a wide-area network link.¹

(1) NFS Services are not supported on X.25 links.

The following illustration shows the relationships among these products.



Relationships Between TCP/IP Services, Transports, and Links

The remaining sections of this chapter contain details about each of these products. For the most current information on environments in which the ARPA, NFS, NS, LAN, and X.25 products can be used, contact your local HP representative.

The ARPA Services Product

The ARPA Services product provides the ARPA/Berkeley services. These services originated from the Advanced Research Projects Agency (ARPA) and the University of California at Berkeley (UCB).

The ARPA Services are used to communicate in HP-UX, UNIX, and non-UNIX environments. The Berkeley Services are used to communicate in HP-UX or UNIX environments.

The ARPA Services product enables your HP 9000 computer to communicate on a LAN with other HP 9000 computers and computers from other vendors. These include Sun Microsystems, IBM PC/AT, and DEC VAX VMS and Ultrix computers that are running ARPA or Berkeley software from a non-HP supplier. You can also communicate with Sun Microsystems computers over an X.25 WAN.

To run the ARPA Services software, you must first install the LAN product or the X.25 product or both, depending on your system and the services you want to use.

ARPA Services

The ARPA Services product includes the following:

- **File Transfer Protocol (ftp)** allows you to transfer files between HP-UX, UNIX, and non-UNIX systems, and perform file management operations on these systems.
- **Telnet (telnet)** allows you to log into a remote HP-UX, UNIX, or non-UNIX host if you have an account on the remote host and it is running ARPA software. This service may also be used over a LAN to communicate from your HP 9000 to HP 1000 computers.
- **Bootstrap Protocol (BootP)** allows some diskless systems, such as the HP 700/X terminal, to load network and configuration parameters from a server on the network.
- **Trivial File Transfer Protocol (TFTP)** allows some diskless systems, such as the HP 700/X terminal, to transfer files containing bootstrap code, fonts, or other configuration information. It can be used in conjunction with BootP.
- **Remote Copy (rcp)** allows data and program files and directories to be transferred between HP-UX or UNIX hosts on the network. This service also allows your HP 9000 to communicate with HP Vectra PCs and IBM PC/ATs over a LAN.
- **Remote Execution (rexec)** is used in programs to execute commands on a remote HP-UX or UNIX host.
- **Remote Login (rlogin)** allows you to log into a remote HP-UX or UNIX host if you have an account on the remote host.

- **Remote Shell** (`remsh`) allows you to execute a command on a remote HP-UX or UNIX host if you have an account on the remote host. This service also allows your HP 9000 to communicate with HP Vectra PCs and IBM PC/ATs over a LAN. `remsh` is the same command as Berkeley's `rsh`.
- **Remote Who** (`rwho`) allows you to list the users on remote systems that are running the `rwho` daemon. This service is not supported over the X.25 link product.
- **Remote Uptime** (`ruptime`) allows you to list the status of remote systems on the network that are running the `rwho` daemon. This service is not supported over the X.25 link product.
- **fingerd** is an HP-UX command that allows remote users to look up user information about your system over the network.
- **Sendmail** (`sendmail`), when installed and configured, routes internetwork mail. Because this service uses ARPA's standard Simple Mail Transfer Protocol (SMTP), you can use it to route internetwork mail to remote or local HP-UX, UNIX, and non-UNIX environments that support ARPA protocols.
- **BIND** (Berkeley Internet Name Domain) name service is an optional network information lookup service. It is an implementation of the ARPA Domain Name System (DNS). Its hierarchical naming scheme allows you to retrieve host names and addresses for any node on the network. It also provides mail routing capability via a list of hosts that will accept mail for an address.
- **Gated** (`gated`) is a routing daemon that dynamically determines routing over internets from one node to another. It allows you to specify which networks you want to communicate with and which you do not. `Gated` handles the RIP, EGP, and HELLO routing protocols.

Interprocess Communication

Berkeley Sockets (BSD IPC) provide interprocess communication used with the Berkeley Services part of the ARPA product. Berkeley Sockets are part of the link products and are described in "The LAN Product" and "The X.25 Product" sections of this chapter.

The NFS Services Product

The NFS Services product enables your HP 9000 computer to share files with other nodes on the same LAN. It gives you remote access to file systems on HP 9000 and Vectra computers, and on non-HP computers (Sun Microsystems, DEC VAX VMS and Ultrix, and IBM PC/AT) running NFS software from non-HP vendors.

Once you attach a remote file system with NFS, most of the user commands you use with your local file system (such as `ls`, `rm`, or `cp`) will also work with the remote file system that you just attached. This enables project teams to integrate remote data or files into local applications, and to maintain consistent files among team members.

The NFS Remote Procedure Call (RPC) function and Remote Procedure Call Protocol Compiler (RPCGEN) make writing distributed applications easier. RPC uses eXternal Data Representation (XDR), which translates data into a computer-independent data format that simplifies the sharing of data and applications among HP and non-HP computers.

NFS Services

The NFS Services product includes the following:

- **Network File System (NFS)** provides remote file access to remote file systems for a specified group of hosts.
- **Remote Execution Facility (REX)** allows users to execute commands on a remote host.
- **Network Lock Manager** permits cooperating processes to synchronize access to shared files.
- **Virtual Home Environment (VHE)**, an optional service, allows users to configure login environments on remote nodes to mirror login environments on their host nodes.
- **Network Information Service (NIS)**, an optional service, is used to centrally administer network data bases. This allows you to administer user id's, group id's, and passwords from one node. No matter which computer on the network requests data, NIS supplies a consistent view of the data on the network at steady state.

The NFS Services also provides these capabilities:

- **Remote Procedure Call (RPC)** allows you to develop applications that access files or processes or execute routines on a remote computer on the network. RPC achieves this by using eXternal Data Representation (XDR).
- **Remote Procedure Call Protocol Compiler (RPCGEN)** assists you in writing RPC applications.
- **eXternal Data Representation (XDR)** translates machine-dependent data formats to a universal data format that can be used by all network hosts using RPC/XDR. This enables HP and non-HP nodes and operating systems to exchange information on the network.

The NS Product

The NS (Network Services) product is an HP proprietary collection of networking services. These services enable your HP 9000 computer to communicate with other HP 9000, HP 3000, HP 1000, and DEC® VAX®/VMS systems that are running NS software. The NS product includes the following:

- **Network File Transfer (NFT)** provides the `dscopy` command to copy files between your HP 9000 and other HP computers on the network using NS software. You may also use NFT to communicate with DEC VAX/VMS computers and IBM PC/ATs that are running NS software.
- **VT3K** provides the ability to have a virtual terminal (VT) session from an HP 9000 workstation to an HP 3000 system. This gives users of HP 9000 workstations access to applications and data bases on HP 3000 MPE V and MPE XL systems that are connected to the same LAN as the workstations.

Interprocess Communication

NetIPC is the interprocess communication facility used with the NS product. It is part of the LAN product and is described in "The LAN Product" section.

The LAN Product

The LAN/9000 Link product provides HP 9000 computers with a network connection to Ethernet or IEEE 802.3 CSMA/CD LANs. The LAN software and hardware provides the basis for network services, and must be installed before running these services over the LAN.

You can run ARPA Services, NFS Services, and Network Services on the LAN link. You can also use the LAN product without the NS, ARPA and NFS products to write customized interprocess communication or application software.

Interprocess Communication

Interprocess communication allows a process to communicate with another process on the same host or a remote host via system calls that access communication connection entities called sockets. The LAN product provides two interprocess communication (IPC) facilities: NetIPC and Berkeley Sockets (BSD IPC).

- NetIPC enables processes running on HP 9000 nodes on the network to exchange information among other HP 9000, HP 1000 A-Series, HP 3000 MPE-V and MPE-XL, HP Vectra PC, and IBM PC nodes on the network. NetIPC provides an interface between Application Layer services, such as ARPA, NFS, or NS, and transport protocols in the Transport Layer, such as TCP/IP. A module in NetIPC, called the socket registry, translates user-defined names into machine addresses.
- Berkeley Sockets (BSD IPC) enable processes running on UNIX nodes on the network to exchange information. HP's implementation of sockets is based on the IPC in the Berkeley Software Distribution of UNIX, version 4.3 (4.3 BSD).

Link Level Access

Link Level Access (LLA) allows you to implement special-purpose network protocols by directly accessing the network interface drivers. LLA may be used on HP 9000 computers.

The X.25 Product

The X.25/9000 Link product provides HP 9000 computers with a connection to public and private X.25 WANs. The X.25 software and hardware provides the basis for network services, and must be installed before running these services over the WAN.

You can run ARPA Services (except ruptime and rwho) and Network Services on the X.25 link. You may also use the X.25 product without the ARPA and NS products to write customized interprocess communication or application software.

Interprocess Communication with Berkeley Sockets

Interprocess communication allows a process to communicate with another process on the same host or a remote host via system calls that access communication connection entities called sockets. The X.25 product provides a Berkeley Sockets Interprocess Communication (BSD IPC) facility that is implemented in one of the following ways:

- Via TCP/IP or UDP/IP at the OSI Transport Layer (Layer 4).
- By directly accessing the X.25 Packet Layer (X.25 Layer 3; OSI Layer 3).

Refer to the *X.25 Programmer's Guide* for details.

TCP/IP Networking Terms

The following terms commonly appear in documents and literature about TCP/IP networks.

IP Addresses

A node can have several network interface cards installed in it. Each of these network interface cards must have a unique **internet address**. The internet address enables a node to recognize communications that are addressed to it.

Because it is easier to refer to nodes by names than by internet addresses, each node on the network is also assigned a name. Depending on the type of network services you are using, you assign node names with either the `hostname` or the `nodename` command.

- The ARPA Services and the NFS Services use the **host name** assigned with the `hostname` command. These services use a routine to map remote host names to internet addresses. The routine accesses the database that is stored in the file `/etc/hosts`, or accessed via Network Information Service (NIS) or BIND (ARPA/Berkeley).

For you to connect to other hosts, their host names and internet addresses must be in your `hosts` database. For other hosts to connect to your host, your host name and internet address must be in their `hosts` database.

Note that ARPA Services and NFS Services may also use internet domain-style host names instead of names assigned with the `hostname` command.

- The Network Services (NS) product uses the **node name** assigned with the `nodename` command. NS also uses a different method to map remote host names to internet addresses. It broadcasts a Probe request on the network for the internet address associated with the node name of interest. The host with that node name, or another host responding to Probe requests by proxy, responds with the requested internet address.

Multi-homing

An HP 9000 computer can physically contain more than one network interface card. This capability is called **multi-homing**. The advantage of multi-homing is that a computer can have multiple internet addresses. Multiple internet addresses allow you to use the same computer to communicate with many LANs or WANs.

LAN-to-LAN Routers

With the LAN/9000 product, an HP 9000 computer can serve as a **LAN-to-LAN router**. As such, it can forward messages between two networks. A router physically contains more than one network interface card. This capability, called **multi-homing**, allows the computer to be connected to multiple networks at the same time. This capability also permits connections in WAN (Wide Area Network), WAN-to-LAN, and WAN-to-WAN configurations.

Subnetting

Subnetting is an internet addressing scheme that allows you to divide a logical network into several smaller physical networks. Dividing your network into smaller subnetworks, if well-planned, increases the overall efficiency of your network by reducing congestion.

Gateways

A network **gateway** is a device used to connect two or more networks together. The gateway routes information among the networks to which it is connected. Sometimes a gateway with the same type of network interface cards is referred to as a router or an IP router. An X.25 to LAN gateway is also referred to as an IP router for the TCP/IP traffic.

HP 9000 OSI Networking Overview

This chapter provides an overview of HP's OSI networking products. It also defines terms that apply to OSI networking.

Overview

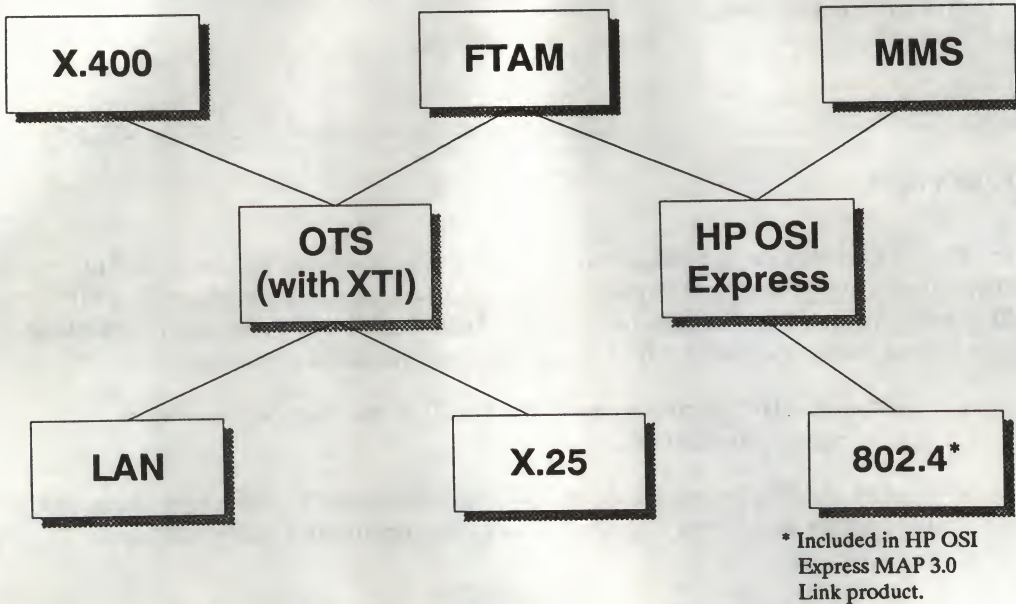
The HP-UX OSI solution is a collection of OSI products developed and integrated to satisfy industry and government requirements for standard multivendor networking. HP's OSI offerings demonstrate a commitment to standards-based, non-proprietary networking for multivendor interoperability. HP-UX OSI products include the following:

- X.400, a standard electronic messaging (mail) service that can be used for multivendor electronic mail.
- FTAM, the File Transfer, Access and Management service. FTAM is a standard file transfer and file management service that operates in a multivendor environment.
- MMS, the Manufacturing Message Specification. MMS is a standard language for communicating with factory automation devices such as robots or programmable language controllers (PLCs).
- OTS, the OSI Transport Service, which supports both FTAM and X.400 services. OTS includes programmatic access to the transport layer via the X-Open Transport Interface (XTI).

The above products run over the following link products:

- X.25/9000, a wide-area network link.
- LAN/9000, a local-area network 802.3 link.
- HP OSI Express MAP 3.0 Link, a network link that supports HP's MAP 3.0 services on an IEEE 802.4 network.

The following illustration shows the relationships among these products.



Relationships Between OSI Services, Transports, and Links

The remaining sections of this chapter contain details about each of these products. For the most current information on environments in which these products can be used, contact your local HP representative.

The X.400 Product

The X.400 product offers standards-based electronic mail for HP 9000 computers. With X.400, HP-UX mail users can send and receive electronic mail messages throughout a multivendor network. A designated HP-UX system running X.400 serves as a gateway, providing access to the X.400 environment for multiple HP-UX systems.

The X.400 product conforms to OSI specifications, including the 1984 CCITT X.400 specification and related NIST, COS, and European standards (CEPT (A311) and CEN/CENELEC (A3211)). The X.400 product provides format and text conversion, addressing, and other common electronic mail functions.

The interface to X.400 is through the familiar ARPA `sendmail` mail utility. Future releases are expected to support a direct user interface to X.400.

The FTAM Products

HP has implemented the ISO File Transfer, Access and Management Standard (ISO 8571), called FTAM (pronounced *eff tam*). FTAM provides true multivendor file system interoperability for HP 9000 computers. It permits transfer, access or management of defined file types between HP 9000 and diverse OSI end systems, regardless of their hardware or operating system.

The basic capabilities of FTAM are the following:

- Text and binary file transfer.
- Record-level access to remote files.
- Management of remote files.

HP offers two FTAM implementations, targeted at two distinct markets:

- HP FTAM/9000 addresses the need for data exchange between dissimilar computers in technical, office, and scientific environments. FTAM/9000 is a fully compliant US GOSIP Version 1 implementation of FTAM. Running over OTS, FTAM/9000 is also compatible with principal European (CEN/CENELEC, UK GOSIP) and Pacific Region (POSI) standards. HP FTAM/9000 is designed to coexist on networks with TCP/IP and ARPA services. In this configuration, TCP/IP and OSI protocol stacks share existing 802.3 or X.25 links.

- HP MAP 3.0 FTAM addresses the need for data exchange in multivendor manufacturing environments. FTAM, used with the HP OSI Express MAP 3.0 Link, connects HP 9000 (Series 600, 700, and 800) computers to broadband or carrierband 802.4 MAP 3.0 networks.

HP's FTAM products include three key interfaces:

- An interactive, ftp-like interface.
- A command-line, rcp-like interface.
- A programmatic interface for C.

The MMS Product

HP has implemented the ISO draft standard ISO/DIS 9506, (Manufacturing Message Specification). MMS is the language which MAP-connected cell controllers use to direct the activities of factory-floor devices such as robots, PLCs (programmable logic controllers), and NC (numerical control) machines.

HP MAP 3.0 MMS addresses the need for device and process control in multivendor manufacturing environments. MMS implements comprehensive, direct control of factory-floor devices that conform with MAP 3.0. Control is implemented through specialized communication capabilities such as read/write variables and start/stop/resume programs.

The interface to HP's MMS product is the industry-standard programmatic (C-language) interface, commonly called MMSI. Over 90 functions are available to the MMS application developer. Key functions within MMS include the following:

- Context (connection) Management.
- Variable Access.
- VMD Support.
- Program Invocation Management.
- Domain Management.
- File Management.
- Operator Communications.

MMS for HP 9000 (Series 600, 700, and 800) computers uses the HP OSI Express MAP 3.0 Link, a fully compliant IEEE 802.4 implementation. MMS can also run over IEEE 802.3 networks via the OTS transport.

The OTS Product

OTS, the OSI Transport Service, is HP's general purpose transport for OSI networking. It consists of layers four and five of the OSI network model. It can use either the X.25 link or LAN (IEEE 802.3) link, and supports FTAM, MMS, and X.400 services.

OTS includes the X-Open Transport Interface (XTI), which provides programmatic access to layer 4 (Transport) of the OSI network model. XTI provides developers of specialized applications with access to networks conforming to OSI standards. Using XTI is similar to using Berkeley sockets.

The X.25 Product

The X.25/9000 Link product provides a network connection to public and private X.25 packet-switching networks for HP 9000 computers. An X.25 link requires at least OTS (and most often FTAM or X.400) to comprise a communications subsystem.

The X.25 product is certified on major public and private X.25 networks. It complies with the 1980 and 1984 CCITT recommendation for X.25, and with ISO 7776 and 8208.

The LAN Product

The LAN/9000 Link product provides OTS with connectivity to an IEEE 802.3 network. It is supported on both HP 9000 computers. OTS uses link-level access (LLA) to the LAN card to gain access to the data link and physical layers of an 802.3 network.

OSI Networking Terms

The following terms commonly appear in documents and literature about OSI networks.

OSI Addresses

Depending on the service involved, OSI networks use different addressing schemes to identify message destinations. HP's OSI services use one of two addressing methods:

- X.400 uses **Originator/Recipient (O/R)** addresses to specify destinations for messages.
- FTAM and MMS use **Directory Distinguished Names (DDNs)** to identify message destinations.

Each DDN or O/R address is unique, and consists of multiple attributes (such as country, organization, or name) that fully specify the destination. O/R addresses and DDNs are configured by the network manager when the service is installed. The exact configuration procedure depends on which transport (OTS or OSI Express) underlies the service.

CLNS and CONS Networks

CONS stands for Connection Oriented Networking Service. CLNS stands for Connectionless Network Service. These terms apply to layers 3 or 4 of the network, and describe how two nodes interact.

In a CONS network, two systems establish a network-layer connection at the beginning of their communication. The connection is broken at the termination of the communication. An analogy can be made to a phone connection, which you establish by dialing and terminate by hanging up. CONS networks are typical where there are a large number of potential destinations available over a less reliable medium. For example, X.400 typically runs transport classes TP2 or TP0 over CONS on an X.25 link.

In a CLNS network, there is no network-layer connection between communicating systems. A courier service might be used to illustrate this type of communication. You give your message to the messenger, and trust it to deliver the message. Similarly, a computer puts its message on the CLNS network, and trusts the network to deliver the message. CLNS networks are typical where the potential destinations are fewer and well-known, and the delivery medium is highly reliable. For example, HP's FTAM typically runs transport class TP4 over CLNS on an 802.3 (LAN) link.

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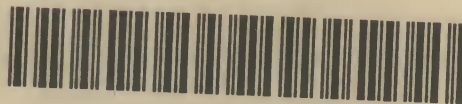
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